Application of optical measurement techniques during fabrication and testing of liquid rocket nozzles

Paul R. Gradl, NASA MSFC

This paper presents a series of optical measurement techniques that were developed for use during large-scale fabrication and testing of nozzle components. A thorough understanding of hardware throughout the fabrication cycle and hotfire testing is critical to meet component design intent. Regeneratively cooled nozzles and associated tooling require tight control of tolerances during the fabrication process to ensure optimal performance. Additionally, changes in geometry during testing can affect performance of the nozzle and mating components. Structured light scanning and digital image correlation techniques were used to collect data during the fabrication and test of nozzles, in addition to other engine components. This data was used to analyze deformations data during machining, heat treatment, assembly and testing operations. A series of feasibility experiments were conducted for these techniques that led to use on full scale nozzles during the J-2X upper stage engine program in addition to other engine development programs. This paper discusses the methods and results of these measurement techniques throughout the nozzle life cycle and application to other components.